

National Aeronautics and Space Administration



Project Status Report

High End Computing Capability Strategic Capabilities Assets Program

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10 August 2012

Successful Webinars Help Jumpstart Use of New Sandy Bridge Processors



- HECC's Application Performance and Productivity (APP) team presented three successful web-based training sessions to help Pleiades users get started quickly using the new Intel Xeon "Sandy Bridge" nodes that went into production in mid-June.
- "How Do I Use the New Sandy Bridge Nodes?" focused on educating users regarding new features and enhancements of the Sandy Bridge processors compared to the three older processor types on Pleiades; the webinar was presented on June 21 three days after users were given access to the new nodes, and was repeated on June 27 to accommodate users who were unable to attend the first session.
- "What is an SBU and Why Should I Care?" was conducted on July 25, and explained how Standard Billing Unit (SBU) rates are determined for the different processor types on Pleiades; it also compared application performance on the processor types and showed users how to determine which type would run their application most economically.
- These three related webinars were well attended by a total of about 70 scientists and engineers from academia, industry, and government agencies in the U.S.
- Links to these and previous webinars can be found at: http://www.nas.nasa.gov/hecc/support/past_webinars.html

Mission Impact: Enabling users to quickly and effectively use the new Sandy Bridge processors and choose the best fit among four existing Pleiades processor types helps alleviate the backlog of PBS jobs waiting in the queue.

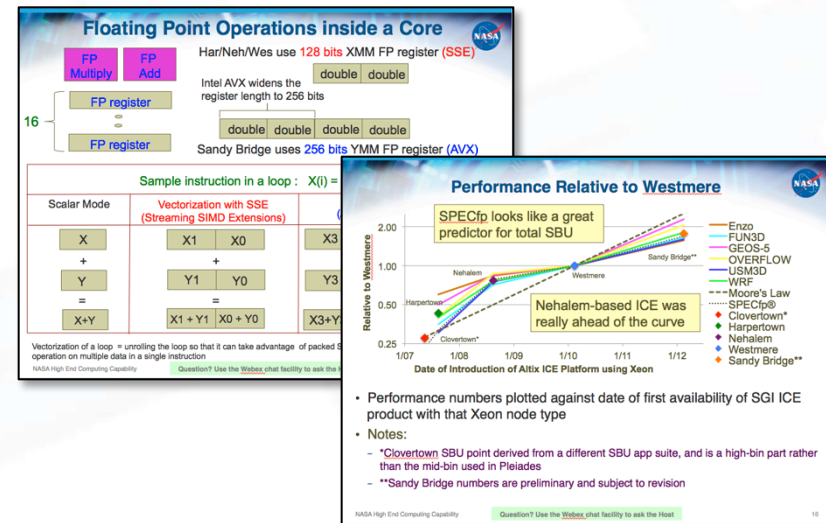


Figure: Slides from the webinars. Left: Effect of the new Advanced Vector Extensions in the Sandy Bridge processors on the efficiency of floating point operations. Right: Performance comparisons of various applications on Pleiades' four generations of Intel Xeon processors.

POCs: Sherry Chang, sherry.chang@nasa.gov, (650) 604-1272, Robert T. Hood, robert.t.hood@nasa.gov, (650) 604-0740
NASA Advanced Supercomputing Division, Computer Sciences Corp.

Record High Usage Shows HECC Provides Critical Resources for NASA Missions



- July 2012 showed record high usage of HECC's supercomputer systems.
- Nearly 5.8 million Standard Billing Units (SBUs) were used by NASA's mission directorates and mission support organizations—exceeding the previous record (from October 2011) of 5.4 million SBUs.
- This increase was enabled by the recent installation and integration of 1,728 Sandy Bridge nodes into the Pleiades system, increasing the Pleiades capacity by 30% and providing 1.24 petaflops of sustained computing power (measured by LINPACK benchmark).
- Researchers in the Science Mission Directorate were the biggest users, consuming approximately 55% of all SBUs.
- Computing resources continue to expand and are made available to users from all mission directorates to support their computing needs.

Mission Impact: Increasing the capacity of the Pleiades supercomputer provides NASA mission directorates with more resources for the accomplishment of their goals and objectives.

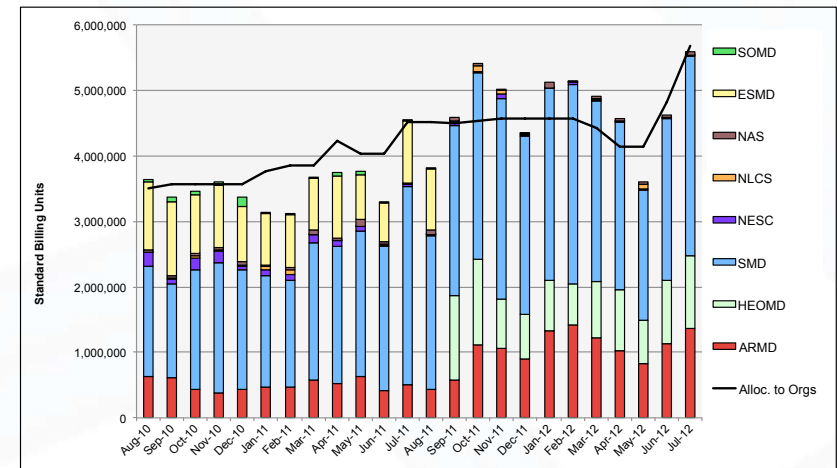


Figure: Utilization of HECC assets by all mission directorates and support organizations. Data is shown in Standard Billing Units (SBUs), where one SBU is equivalent to one node hour of a 12-core Westmere node of Pleiades. Data is normalized to a 30-day month.

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov,
(650) 604-3180, NASA Advanced Supercomputing Division

Network Engineers Improve NEX Transfer Rates By More Than 8X



- Using in-house, automated flow analysis tools, HECC networks engineers identified a poorly performing (100 megabit-per-second), bandwidth-limited, high-transfer host on the NASA Ames local area network, ARCLAN.
- Engineers contacted system users—researchers using Pleiades for NASA Earth Exchange (NEX) computations—and ARCLAN staff to determine available options to improve host connectivity.
- System owners worked with ARCLAN to relocate the NEX host to the Ames data center to enable a 1 gigabit-per-second capability.
- As a result, NEX users obtained an 8x improvement in network performance.
- NEX user Andrew Michaelis reported: “We finally have a decent port with respectable data transfer rates...thanks for all your help...”

Mission Impact: Taking proactive measures developed by HECC staff to identify problem areas of user productivity creates an improved user experience and enables better utilization of HECC assets.

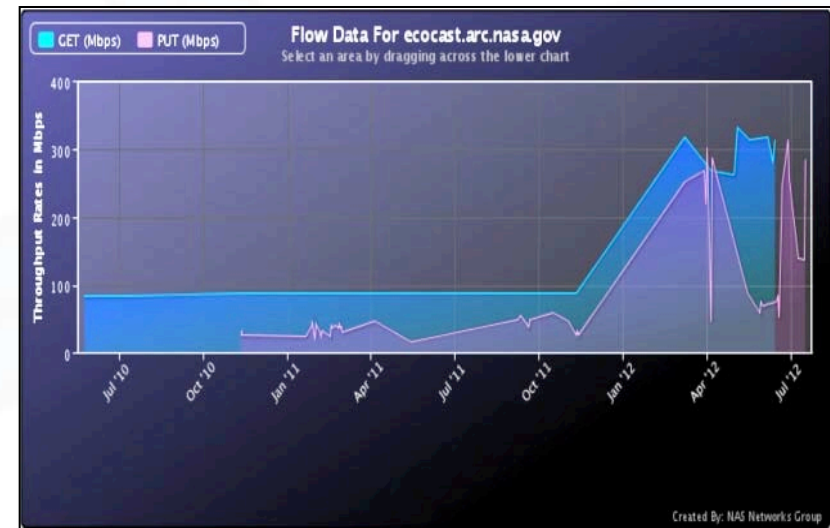


Figure: This graph shows network transfer rates before and after the poorly performing NEX host was identified and moved to the data center at NASA Ames.

POC: Nichole Boscia, nichole.k.boscia@nasa.gov, (650) 604-0891, NASA Advanced Supercomputing Division, Computer Sciences Corp.

ARC Hosts 2012 Summer Short Course for Earth System Modeling and Supercomputing



- The NASA Advanced Supercomputing (NAS) and Earth Science Divisions hosted a new summer course for graduate students and early-career scientists at NASA Ames Research Center, July 16-27, 2012.
- Participants were introduced to the NASA Earth Exchange (NEX), a new platform for scientific collaboration within the Earth science community.
- Attendees learned how to use NASA's high-end computing resources for global climate modeling, terrestrial ecosystem modeling, Earth observation and data analysis.
 - Prominent scientists and subject matter experts delivered lectures on a variety of Earth science and supercomputing topics
 - 8 graduate students from various U.S. universities physically attended and gained hands-on experience using NEX and the Pleiades supercomputer
 - Lectures were broadcast live via webinar to 125-190 online participants and recorded for future use
- Topics included:
 - The Terrestrial Observation and Prediction System (TOPS)
 - Earth observing systems and long-term monitoring from satellites
 - Parallelism in Earth science modeling and data analysis codes
 - “Big data” at NASA and beyond
 - Publishing results and sustaining scientific collaboration
- https://c3.nasa.gov/nex/static/media/project/NEX_Course.html provides a link to the agenda and presentations



Figure: Graduate students from around the country participated in the Earth System Modeling and Supercomputer short course held at NASA Ames from July 16–27, 2012.



POCs: Ramakrishna Nemani, rama.nemani@nasa.gov, (650) 604-6185, Piyush Mehrotra, piyush.mehrotra@nasa.gov, (650) 604-5126; NASA Advanced Supercomputing Division

HECC Experts Resolve Thousands of User Issues During Last Year



- HECC's ticketing system logged over 13,000 user requests for information and assistance in the last year.
- The user community comprises hundreds of U.S. citizens and foreign nationals working on milestones in all of NASA's mission directorates.
- Backed by experts in systems, applications, networking, and visualization, the HECC User Services team responds to phone calls and email from users 24x7, 365 days a year.
- User assistance ranges from handling inquiries about accounts, allocations, jobs, and system status to code modification and optimization, improvements to data transfer times, and development of high-fidelity visualizations of scientific and engineering results.
- User productivity was enhanced through quick response to handle temporary increases in SBU allocations when high priority jobs have been running, as well as the capability to increase disk quotas allowing users to continue analyzing their critical data.

Mission Impact: Providing 24x7 assistance to users saves them time and energy, and enables them to concentrate on meeting mission milestones.

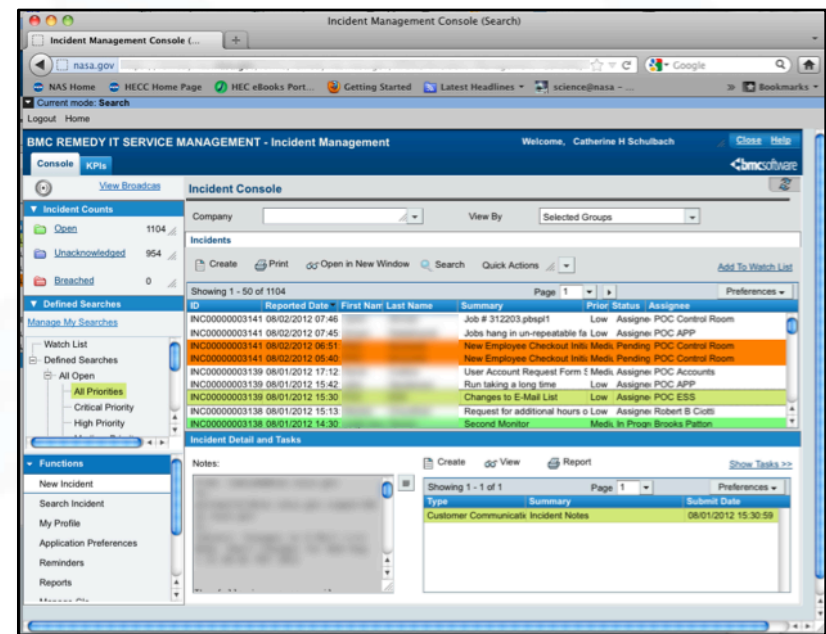


Figure: Screenshot of ticketing system showing requests from the HECC user community.

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

Internal Web Proxy Improves Workflow Management for HECC Support Staff



- The HECC Networks team evaluated, purchased, and put in place a Cisco web proxy appliance that provides secure access to services inside the HECC enclave for support staff.
- This appliance now allows system administrators to use web-based tools to remotely access and configure Fibre Channel switches, tape silo cameras, and InfiniBand routers, as well as networks and security taps.
- The solution also provides a way to meet federal mandates for 12-character passwords by enforcing RADIUS and SecureID authentication to access the devices.
- The appliance requires no client software and no browser reconfiguration, allowing staff to remotely connect to internal resources without client-side modifications.
- So far, 40 devices have been configured to be accessed via the web proxy appliance, with more to come.

Mission Impact: This new appliance provides support staff improved access to internal resources, allowing them to better manage the highly complex HECC environment.



Figure: The new Cisco web proxy appliance allows system administrators to remotely configure devices in the HECC environment and meet federal requirements for secure authentication.

POCs: Nichole Boscia, nichole.k.boscia@nasa.gov, (650) 604-0891; Harjot Sidhu, harjot.j.sidhu@nasa.gov, (650) 604-4935, NASA Advanced Supercomputing Division, Computer Sciences Corp.

CFD Data and Flow Analysis Delivered for SLS DAC2 Lineloads Database



- Computational fluid dynamics (CFD) experts from the NASA Advanced Supercomputing Division delivered a final set of CFD data and flow analysis results for the Space Launch System (SLS) Design Analysis Cycle 2 (DAC2) Lineloads Database.
- Using the CFD code OVERFLOW on Pleiades, the team performed simulations, detailed analyses, and comparisons of 200 clean cases and 12 protuberance cases, including:
 - Surface pressures and Mach contours
 - Simulation convergence histories
 - Lineload comparisons between clean and protuberance configurations
- The team discovered and analyzed asymmetries in the loading on the solid rocket boosters near the skirt ring for the protuberance cases.
- Aside from the SRB asymmetries, overall results showed good comparisons between the clean and protuberance configurations.
- Results were presented to the SLS Loads group on July 25, and will be used for the DAC2 Lineloads Data.

Mission Impact: The computational capabilities delivered by HECC make it possible to compare numerous simulations with varying parameters, increasing the efficiency of the design while minimizing the cost of the design. These computations reduce the number of physical tests required to move from concept to delivery.

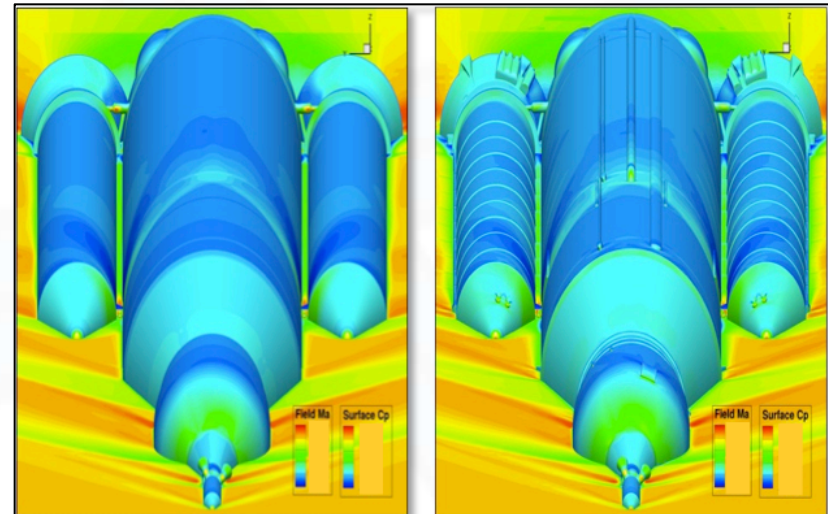


Figure: Comparison of surface pressure and Mach contours for clean geometry and protuberance geometry.

POC: Cetin Kiris, cetin.c.kiris@nasa.gov, (650) 604-4485,
NASA Advanced Supercomputing Division

HECC Resources Enable Modeling of the Sun's Emerging Magnetic Field



- Michigan State University researchers are running non-linear, 3D computational fluid dynamics (CFD) simulations on Pleiades to model the emergence of magnetic fields through the solar surface, and the formation of pores and sunspots.
- Simulations of a supergranule-scale portion of the surface layers of the Sun's convection zone and photosphere have revealed that:
 - Multi-scale solar convection naturally produces a multi-scale hierarchy of magnetic structures
 - Minimally structured, uniform, untwisted, horizontal magnetic fields get stretched and twisted into complex, filamentary loops and “flux tubes”
 - Where sufficient magnetic flux collects, the magnetic field inhibits convective energy transport while radiation continues to cool the surface, forming dark pores
- The computational challenge in modeling convection is to conduct analyses at a high enough Reynolds number to include interactions of very disparate spatial and temporal scales of motion—these calculations would be impossible without the capability of systems like Pleiades.

**HECC provided supercomputing resources and services in support of this work.*

Mission Impact: Results of this research furthers NASA's science goals to understand the Sun and its interactions with the Earth and solar system, as well as what causes variations in the magnetic field on the the solar surface.

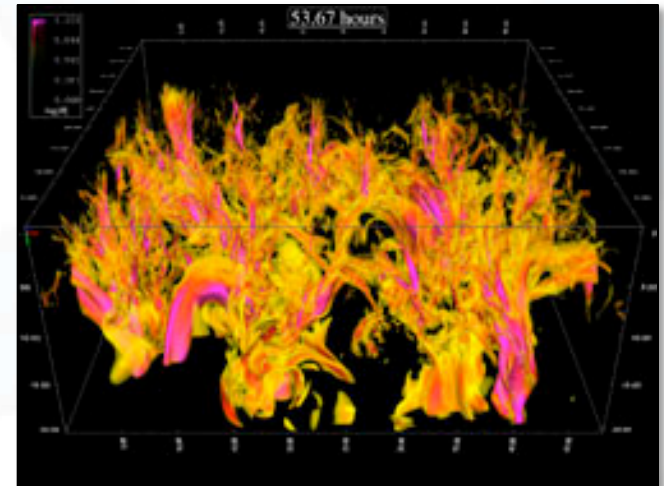


Figure: Visualization of the complex magnetic field produced as magnetic flux rises toward the Sun's surface from the deep convection zone. This snapshot shows how the magnetic field has evolved two days from the time that a uniform, untwisted, horizontal magnetic field started to be advected by inflows at the bottom (20 megameters deep). Robert Stein, Michigan State University; Tim Sandstrom, NASA/Ames

POC: Robert Stein, stein@pa.msu.edu, (517) 884-5613, Michigan State University

Simulations Used to Assess Aerodynamics for Orion MPCV



- NASA Ames engineers are running CFD simulations on Pleiades to assess key performance aspects of the Orion Multi-Purpose Crew Vehicle (MPCV) during launch aborts, atmospheric entry, descent, and landing.
- These simulations capture complex interactions between the Orion Launch Abort Vehicle and its powerful rocket motor plumes to assess whether they might alter intended flight performance.
- CFD simulations of wind tunnel and flight conditions bridge the gap between ground-based experiments and flight conditions by providing corrections to experimental data for non-ideal phenomena, such as wind tunnel model support sting interference; they are also a cost-effective means of assessing aerodynamic effects of incremental design changes.
- The close coordination of physical testing and simulation provides valuable guidance for improving the technology in both disciplines.
- HECC resources have enabled detailed, comprehensive, and timely simulations that provide an essential complement to experimental testing.

**HECC provided supercomputing resources and services in support of this work.*

Mission Impact: Ongoing CFD simulations, run on HECC supercomputing resources, provide the Orion MPCV project with key performance predictions for conditions that are difficult or impossible to obtain using ground-based testing or flight testing.

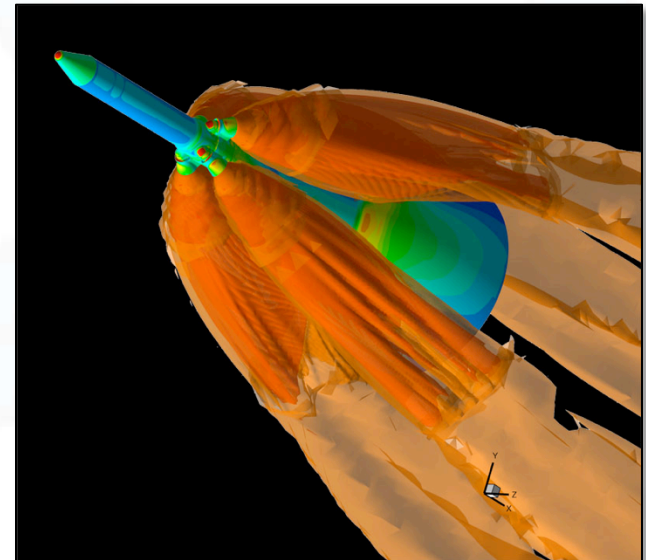


Figure: Plumes from the Orion Launch Abort Vehicle's abort motors at Mach 2.5 and an altitude of 190,000 feet. High-resolution calculations predict the formation of Gortler vortices in the plume's shear layers.
Robert Childs NASA/Ames

POCs: Robert Childs, robert.e.childs@nasa.gov, (650) 604-4166,
Joseph Garcia, joseph.a.garcia@nasa.gov, (650) 604-0614,
NASA Ames Research Center

HECC Facility Hosts Several Visitors and Tours in July 2012



- HECC hosted 5 tour groups in July; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors for the month included:
 - 11 members from the National Research Council Committee on NASA's Strategic Direction, including Dr. Ronald Sega, Committee Vice-Chair, and Michael Turner, committee member.
 - Eight graduate students and early-career scientists who attended the 2012 Summer Short Course for Earth System Modeling and Supercomputing, co-hosted by the NASA Earth Exchange under the NAS Division (see slide 6).



Figure: Bryan Biegel, deputy division chief of the NASA Advanced Supercomputing Division, gave a hyperwall demonstration and tour of the Pleiades supercomputer to visitors.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462,
NASA Advanced Supercomputing Division

Presentations and Papers



- **“US East Coast Offshore Wind Energy Resources and Their Relationship to Peak-time Electricity Demand,”** Michael J. Dvorak et al, Wind Energy, Wiley Online Library, July 25, 2012.*
<http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291099-1824/earlyview>
- **Summer Course on Earth System Modeling and Supercomputing**, July 16–27, 2012
NASA Ames Research Center
 - “Introduction to Parallel Computing,” P. Mehrotra
 - “Parallelism in Earth Science Modeling and Data Analysis Codes-I,” J. Chang
 - “Parallelism in Earth Science Modeling and Data Analysis Codes-II,” D. Kokron
 - “Big Data at NASA and Beyond,” H. Pryor
 - “I/O Patterns in MPI Programs: Including Libraries,” S. Heistand
 - “Debugging,” J. Chang
 - “Programming Frameworks: ESMF,” D. Kokron
 - “Terrestrial Observation and Prediction System (TOPS),” R. Nemani
https://c3.nasa.gov/nex/static/media/project/NEX_Course.html
- **“Genesis of Twin Tropical Cyclones as Revealed by a Global Mesoscale Model: The Role of Mixed Rossby Gravity Waves,”** Bo-Wen Shen et al, Journal of Geophysical Research, Vol. 117, July 2012.*
<http://www.agu.org/pubs/crossref/2012/2012JD017450.shtml>

**HECC provided supercomputing resources and services in support of this work.*

Presentations and Papers (cont.)



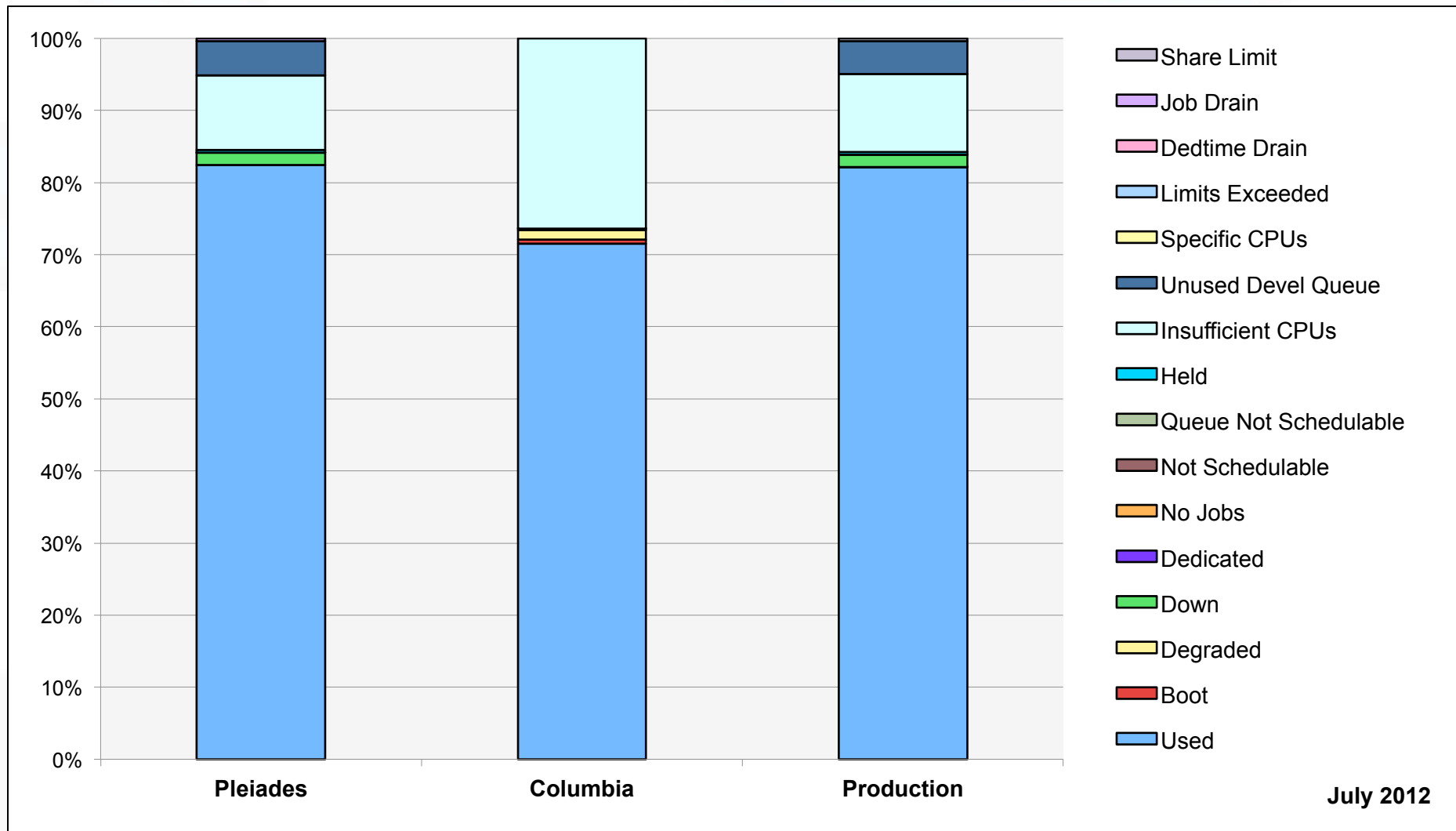
- **7th International Conference on Computational Fluid Dynamics (ICCFD7)**, July 9–13, 2012, Big Island of Hawaii, <http://www.iccfd.org/iccfd7/index.html> *
 - “Improved Finite-Volume Method for Radiative Hydrodynamics,” A. Wray
 - “Advances in Domain Connectivity for Overset Grids Using the X-Rays Approach,” W. Chan, N. Kim, and S. Pandya
 - “Numerical Dissipation and Wrong Propagation Speed of Discontinuities for Stiff Source Terms,” H. Yee, D. Kotov, and B. Sjöspeaker
 - “Detached-Eddy Simulation Based on the v2-f Model,” S. Jee and K. Shariff
 - “Constraint-based Shape Parameterization for Aerodynamic Design,” G. Anderson, M. Aftosmis, and M. Nemec
 - “Design and Evaluation of a Pressure Rail for Sonic Boom Measurement in Wind Tunnels,” S. Cliff, A. Elmilgui, M. Aftosmis, S. Thomas, J. Morgenstern, and D. Durston
 - “Towards Hybrid Grid CFD Simulations of the Launch Environment,” S. Moini-Yekta, M. Barad, E. Sozer, J. Housman, C. Brehm, and C. Kiris
 - “Overheating Anomalies during Flight Test due to the Base Bleeding,” D. Luchinsky, H. Hafiychuck, V. Osipov, E. Ponizhovskaya, V. Smelyanskiy, M. Dagostino, F. Canabal, and B. Mobley
 - “Effect of Inflow Boundary Conditions on Hovering Tilt-Rotor Flows,” U. Kaul
 - “Advances in Rotor Performance and Turbulent Wake Simulation using DES and Adaptive Mesh Refinement,” N. Chaderjian
 - “External Aerodynamics Simulations on the D8 "Double-Bubble" Aircraft Design,” S. Pandya

**HECC provided supercomputing resources and services in support of this work.*



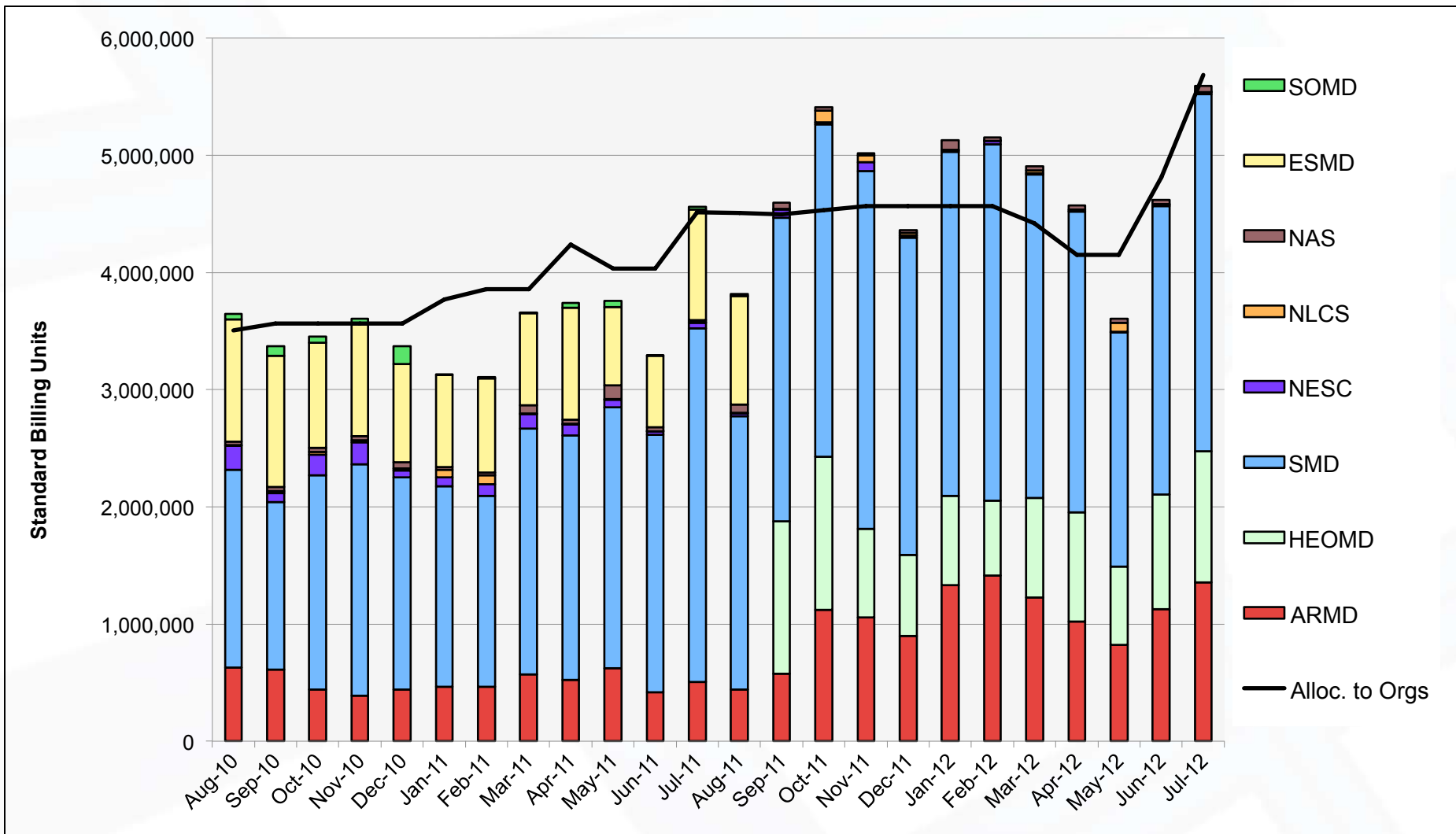
- **SUSE Linux powers 147,456-core German supercomputer**, *Ars Technica*, July 27, 2012
– This article announcing a new German supercomputer running SUSE Linux mentions Pleiades as a “prominent example of SUSE-powered supercomputers.”
<http://arstechnica.com/information-technology/2012/07/suse-linux-powers-147456-core-german-supercomputer/>
- **New NASA Supercomputer Facility Set to Advance Earth Research**, *official NASA Ames press release*, July 23, 2012 – Announces the NASA Earth Exchange as a new supercomputing facility. The release was picked up by numerous media sources, including HPCwire, which published an expanded story naming Pleiades as the NEX HEC resource.
<http://www.nasa.gov/centers/ames/news/releases/2012/12-53AR.html>
- **High-Performance, Multi-Node File Copies and Checksums for Clustered File Systems**, *NASA Tech Briefs*, June 2012 – Information technology article summarizing work done by NAS’s Paul Kolano and Robert Ciotti, as part of a full technical support package (ARC-16494-1) that is available for download.

HECC Utilization

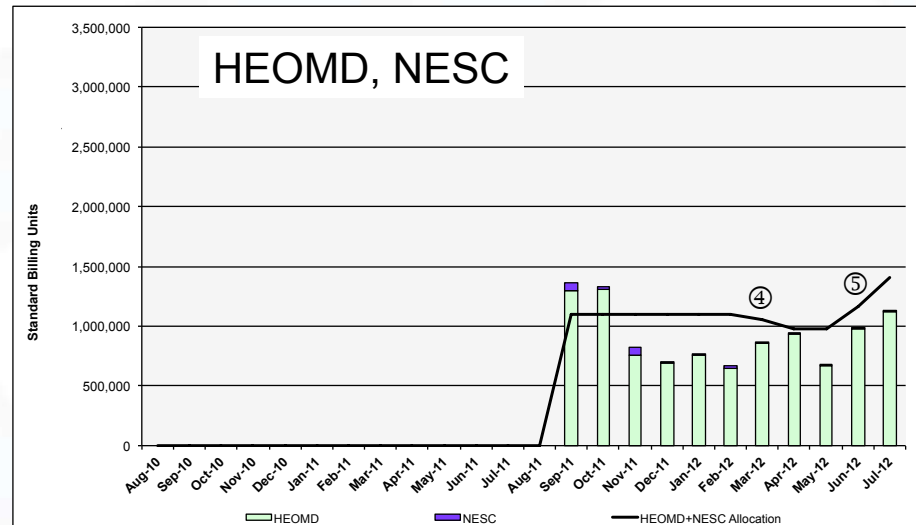
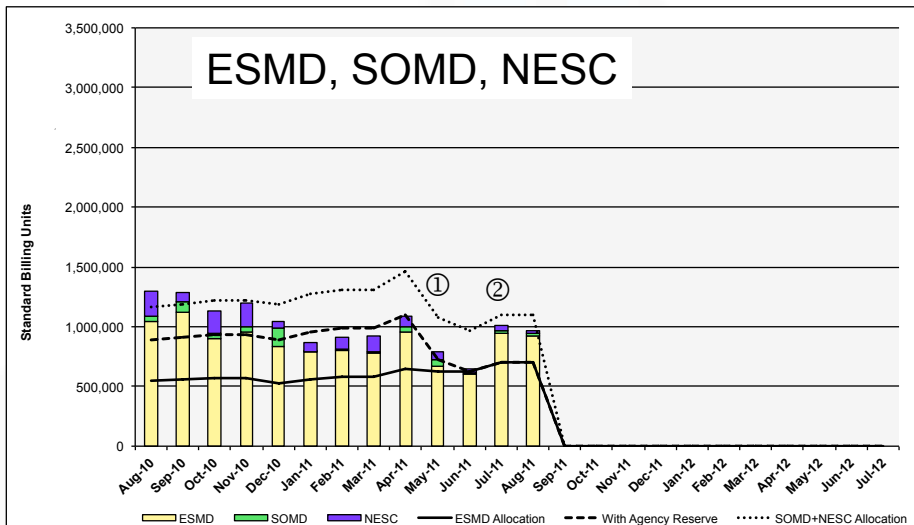
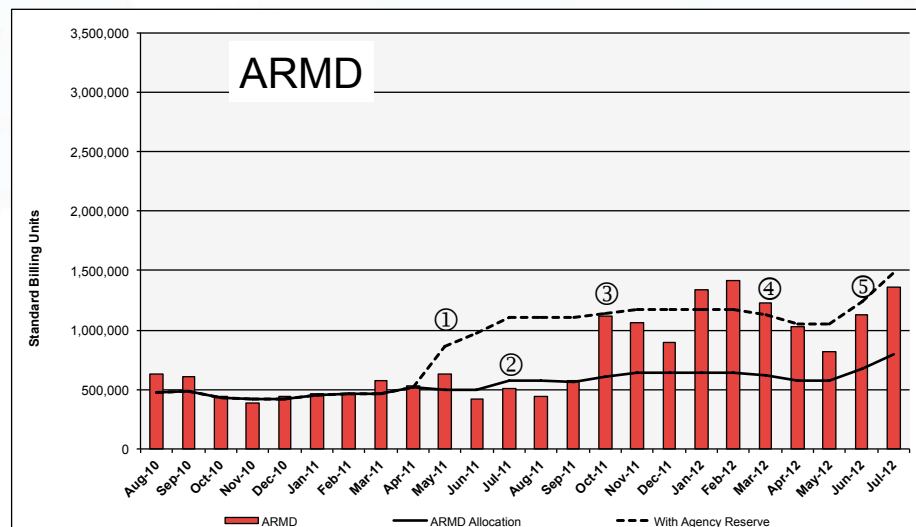
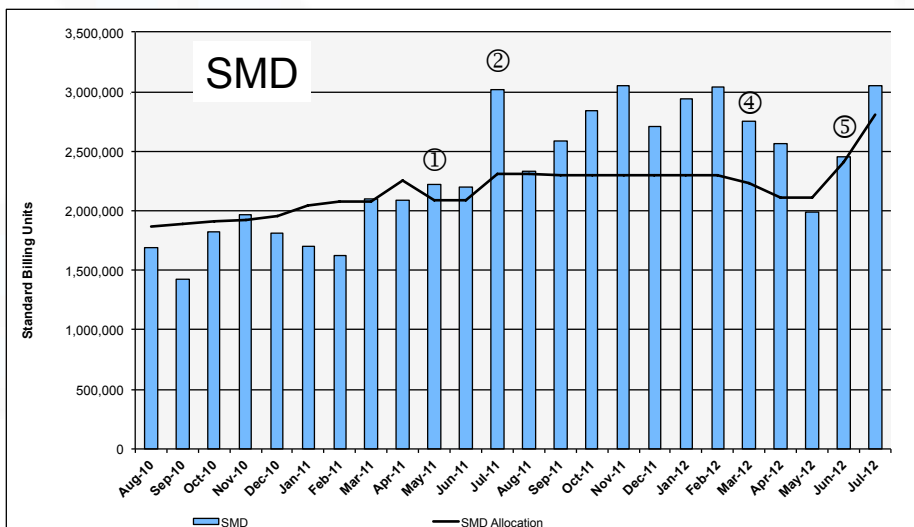


July 2012

HECC Utilization Normalized to 30-Day Month

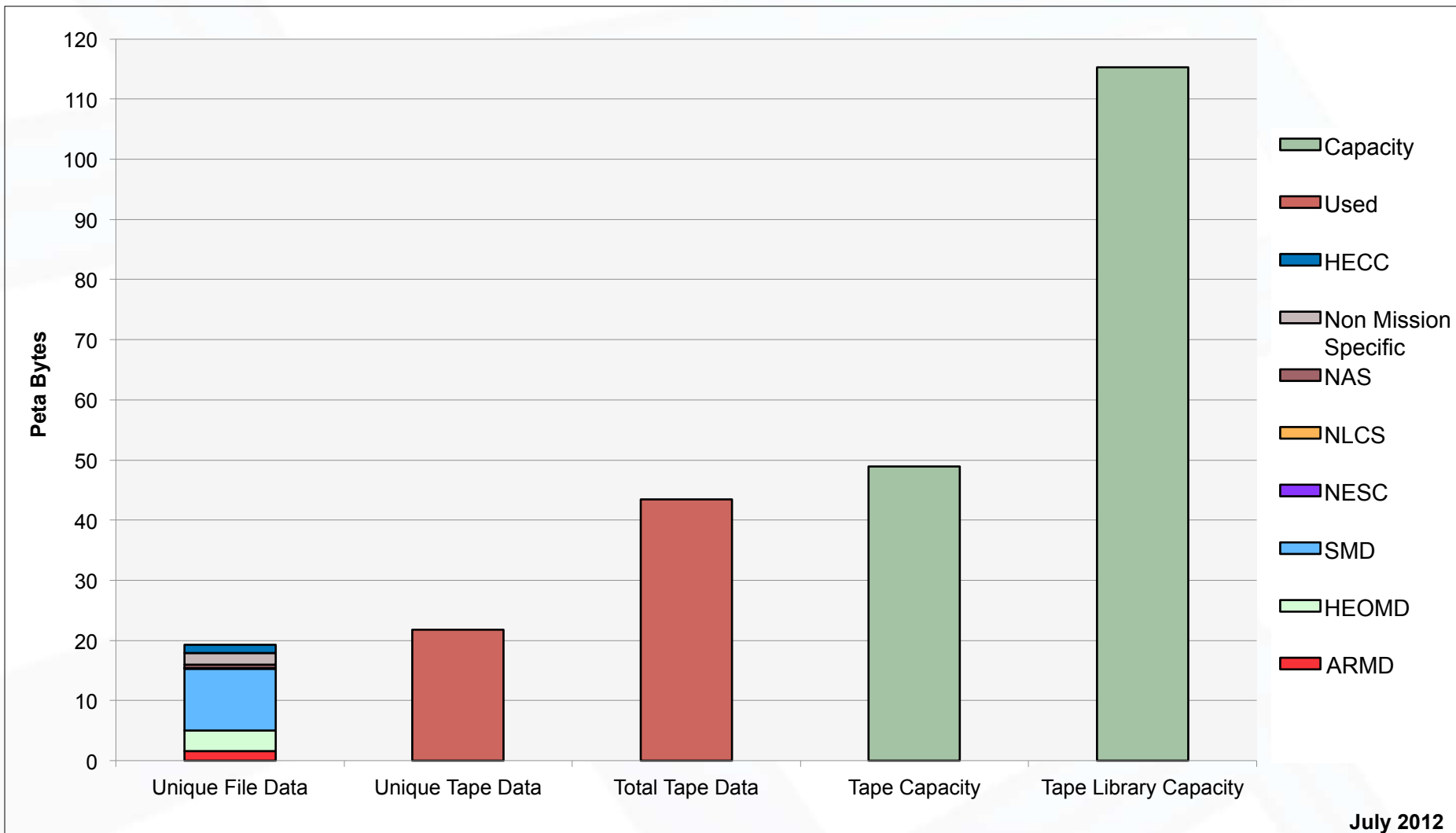


HECC Utilization Normalized to 30-Day Month



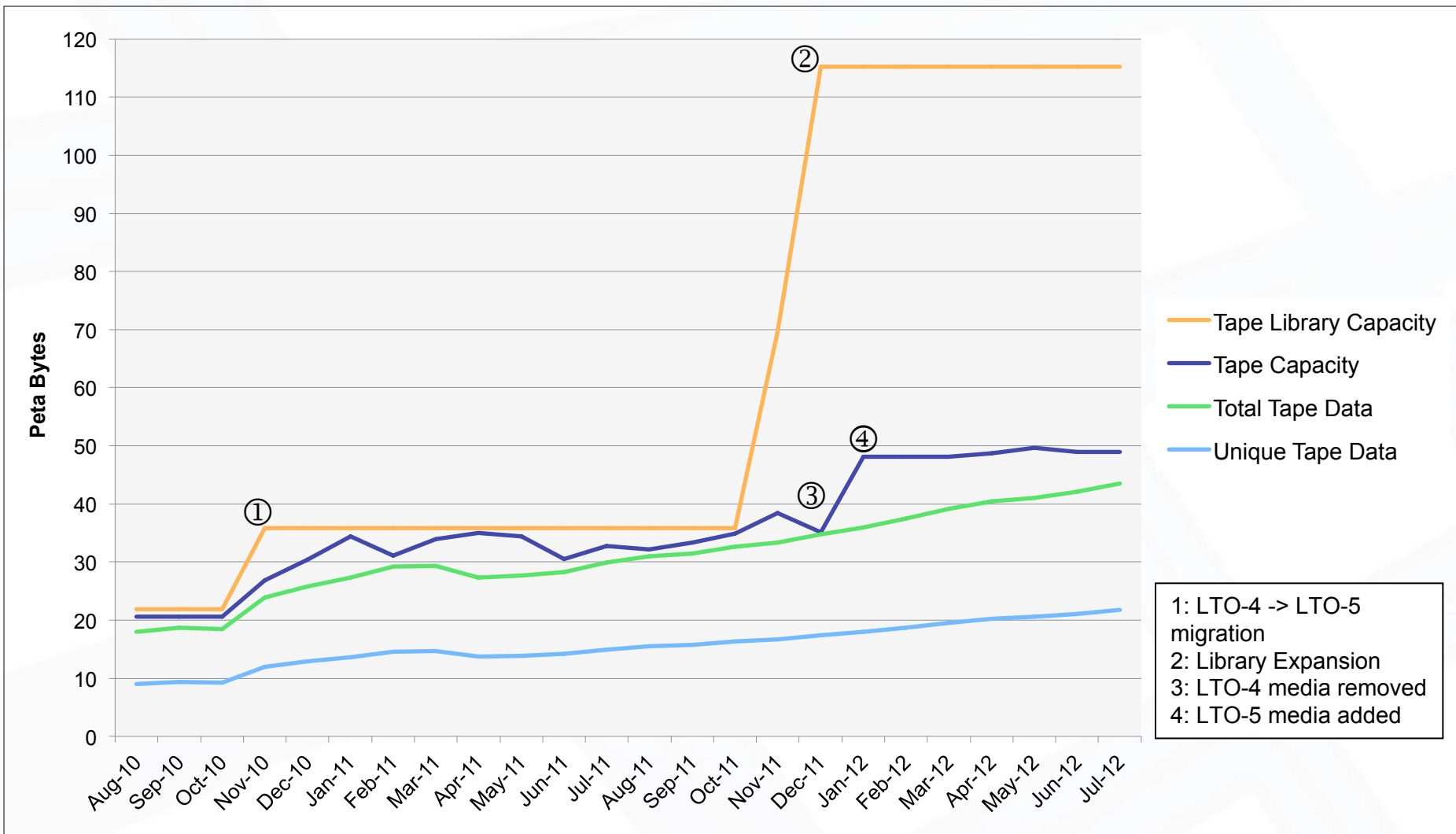
- ① Allocation to orgs. decreased to 75%, Agency reserve shifted to ARMD ② 14 Westmere racks added
 ③ 2 ARMD Westmere racks added ④ 28 Harpertown racks removed ⑤ 24 Sandy Bridge racks added

Tape Archive Status

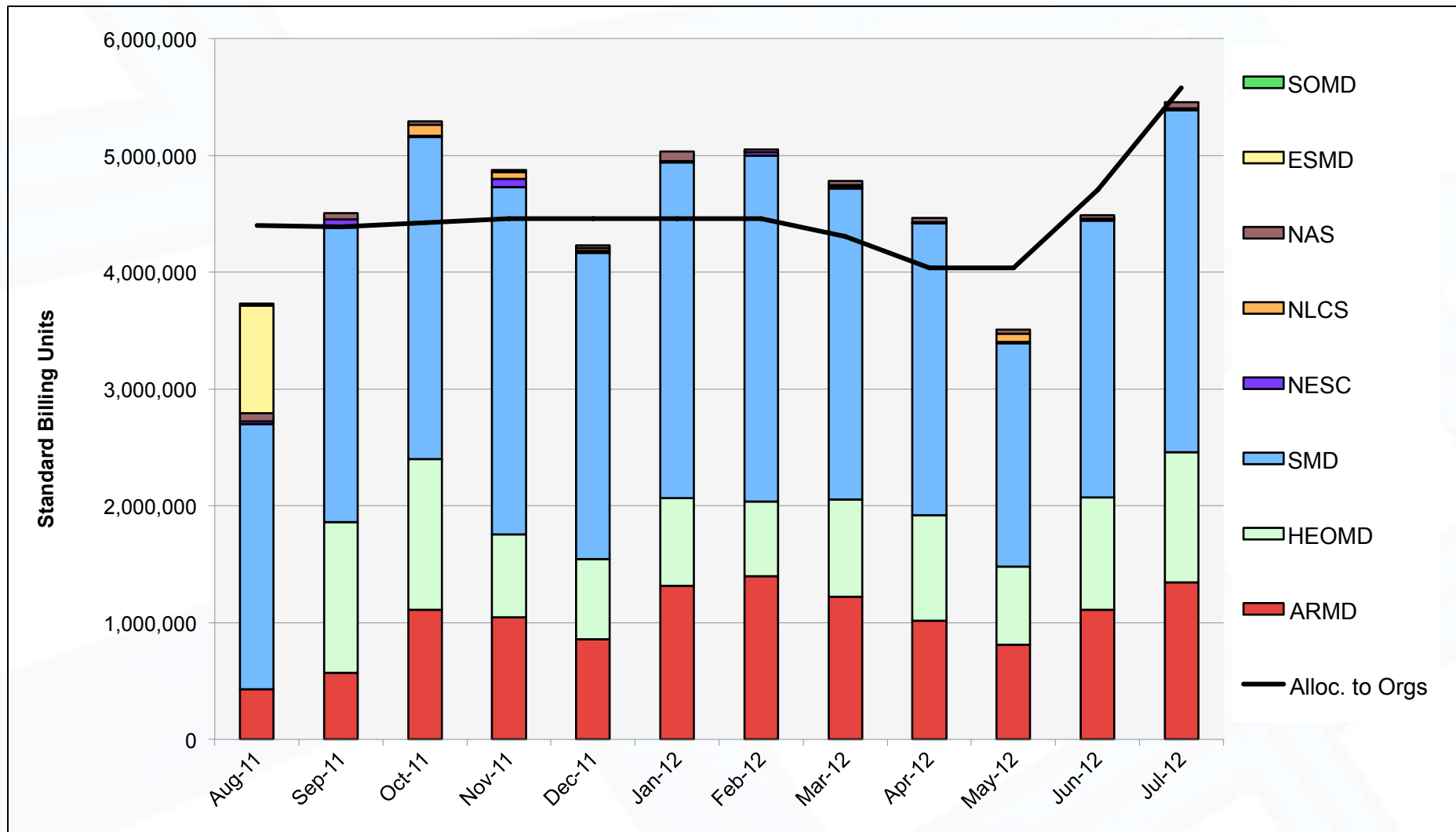


July 2012

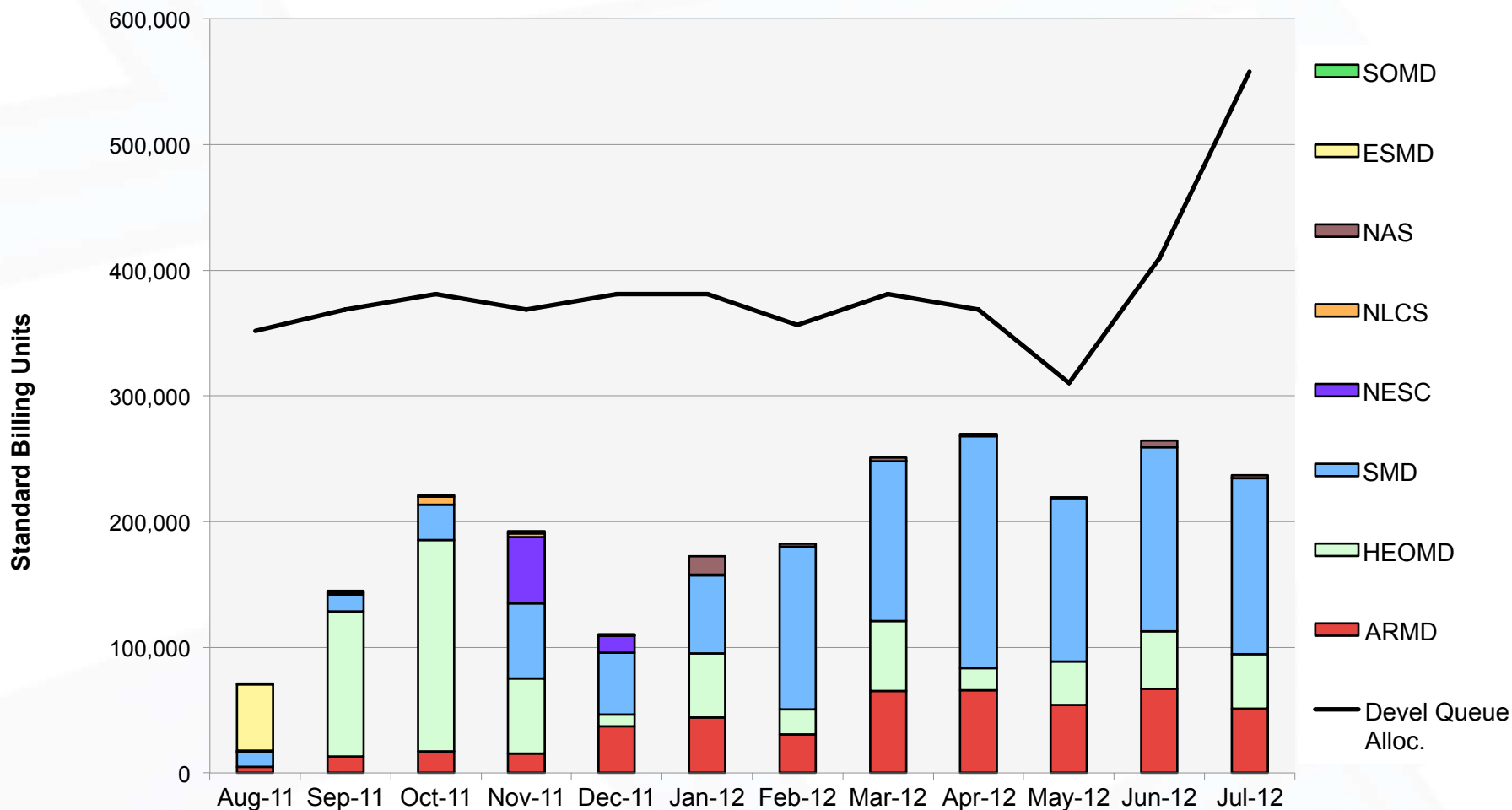
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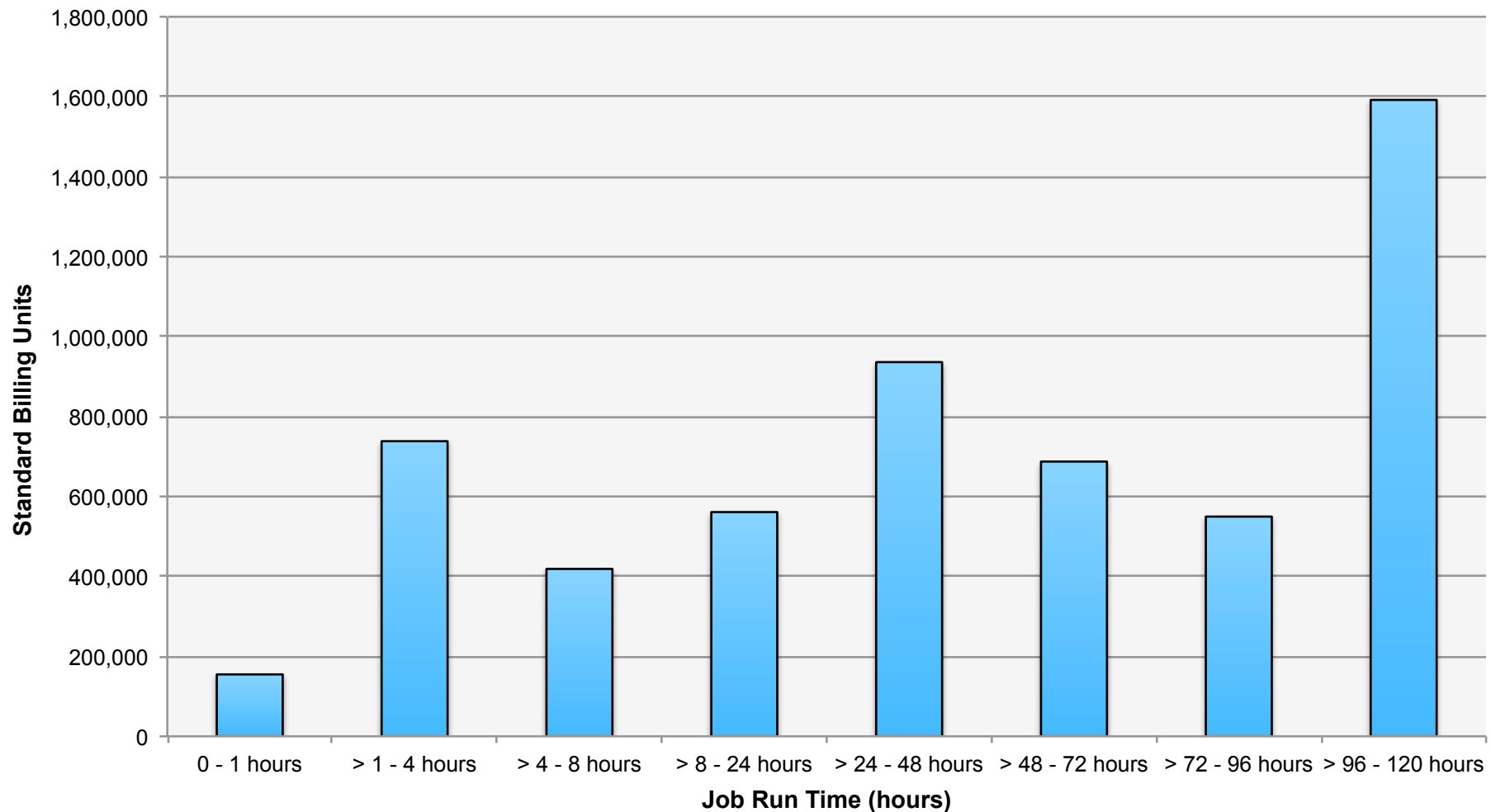
Pleiades: SBUs Reported, Normalized to 30-Day Month



Pleiades: Devel Queue Utilization

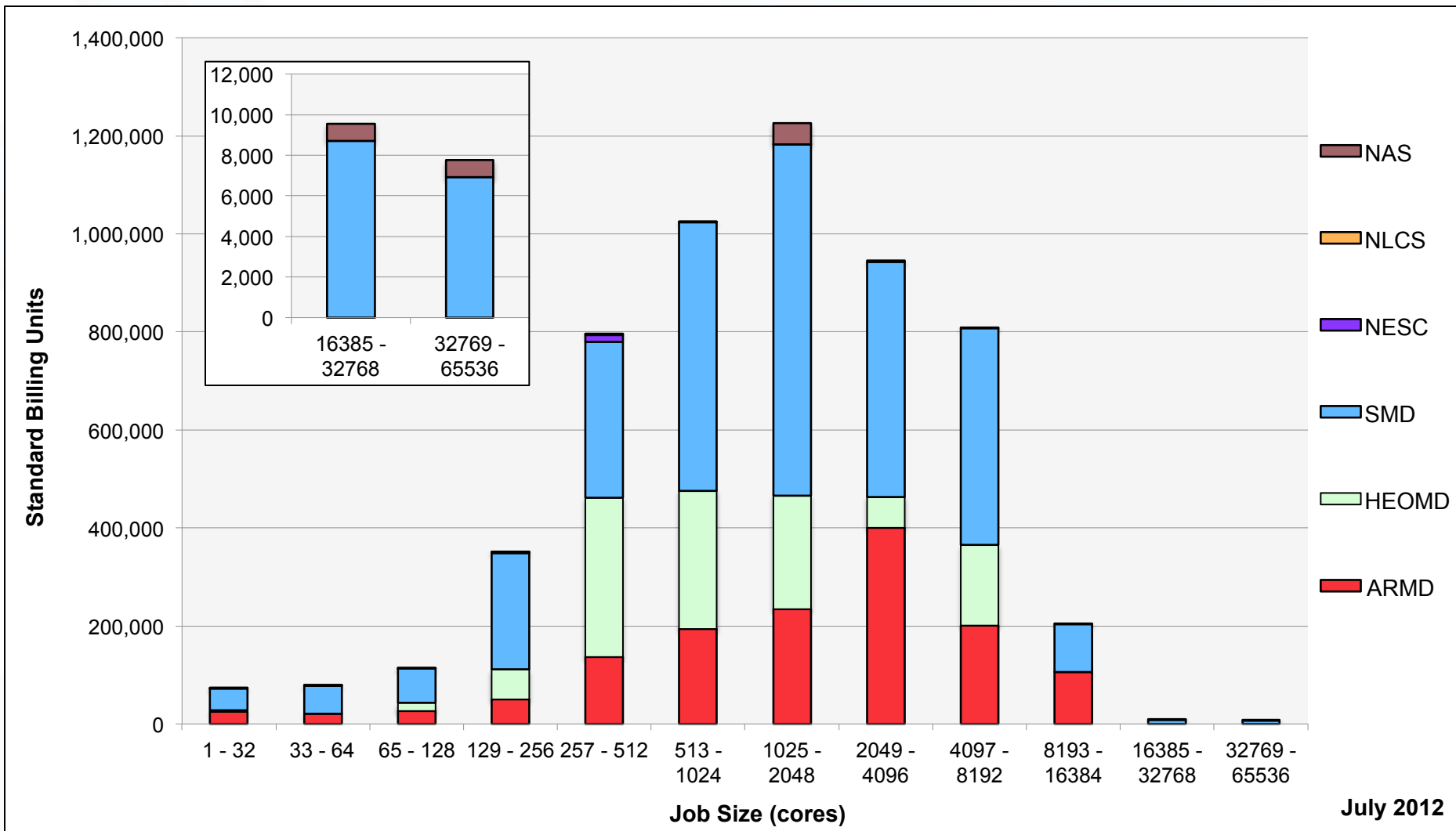


Pleiades: Monthly SBUs by Run Time

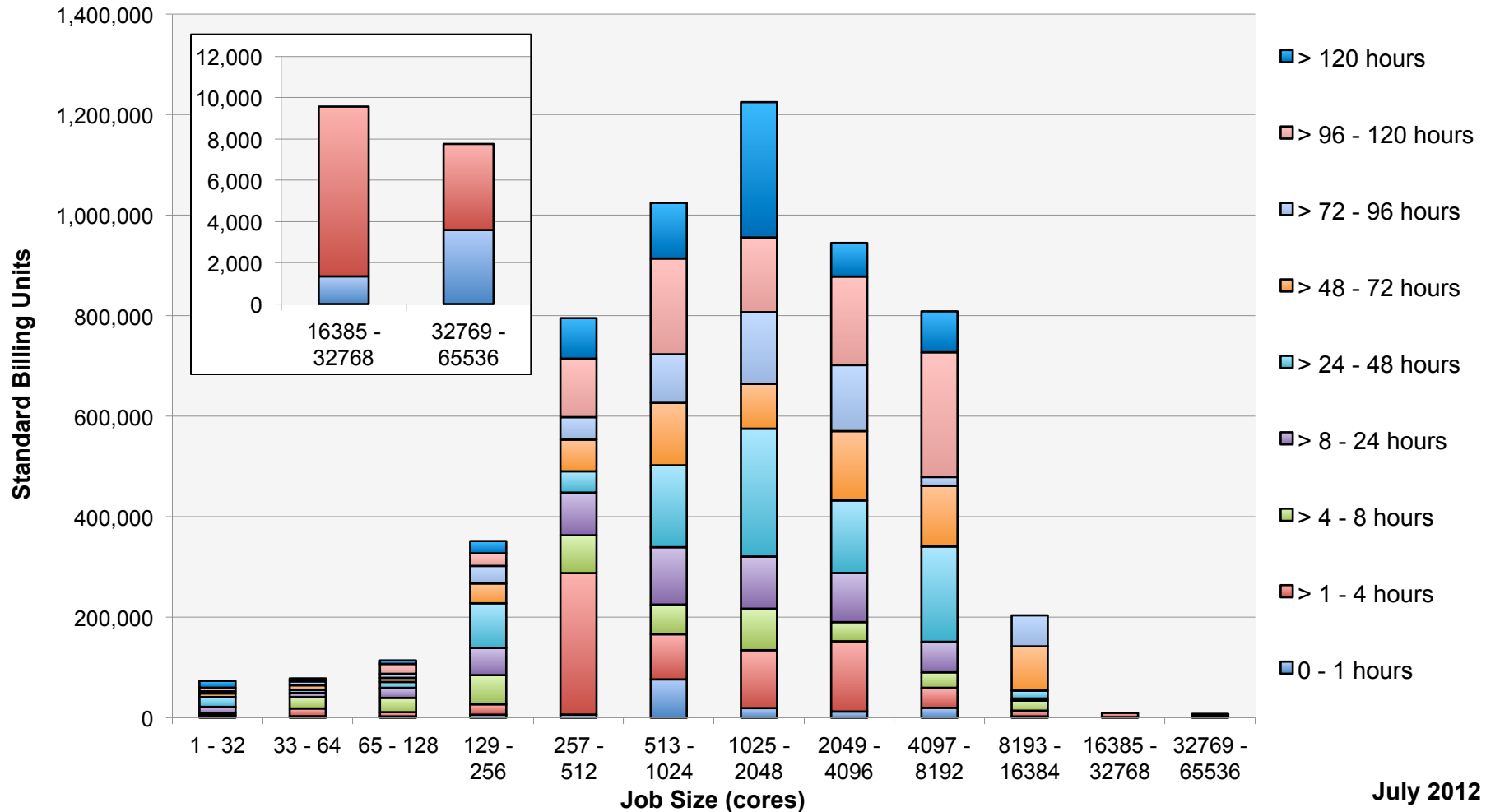


July 2012

Pleiades: Monthly Utilization by Size and Mission

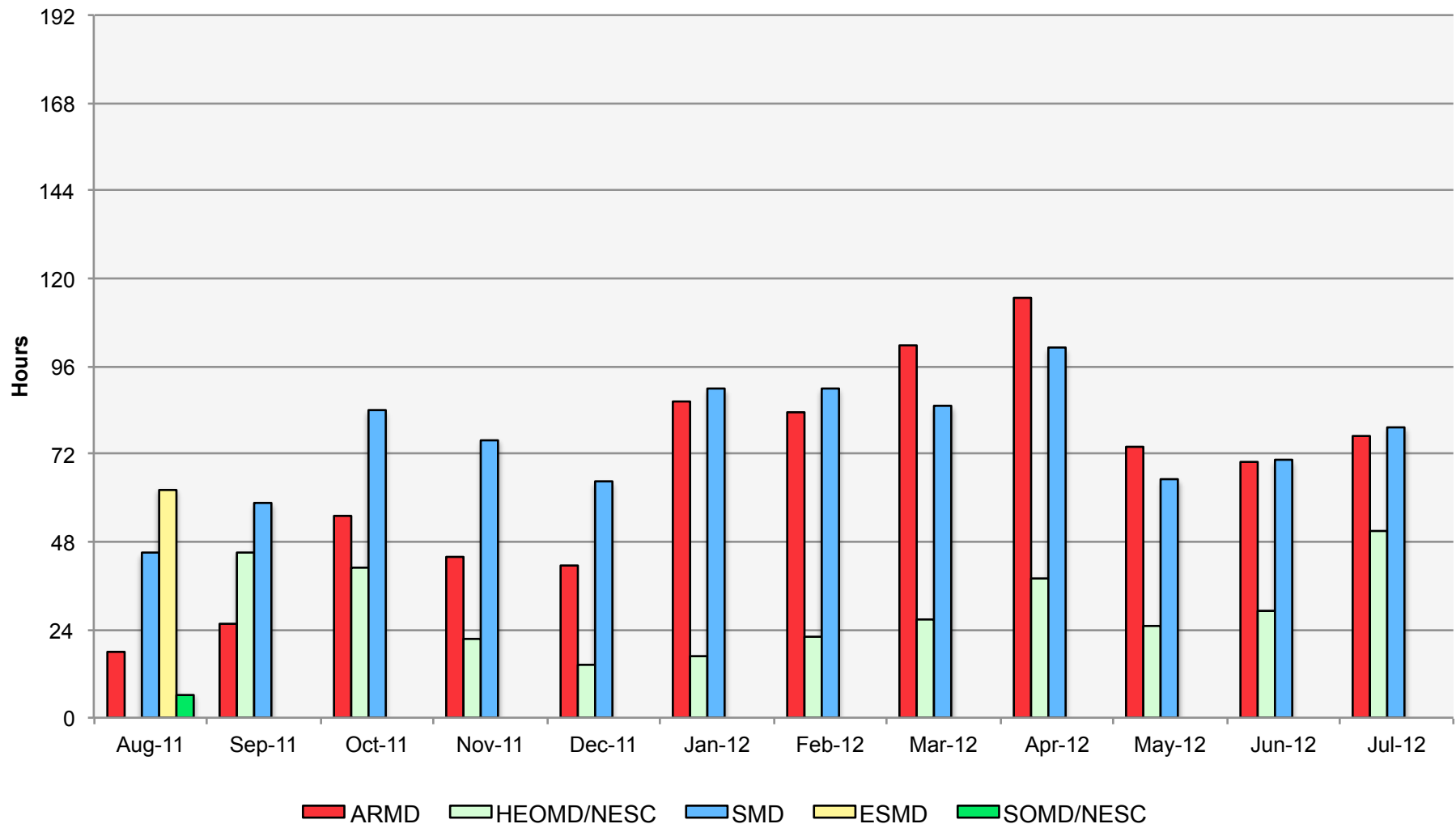


Pleiades: Monthly Utilization by Size and Length

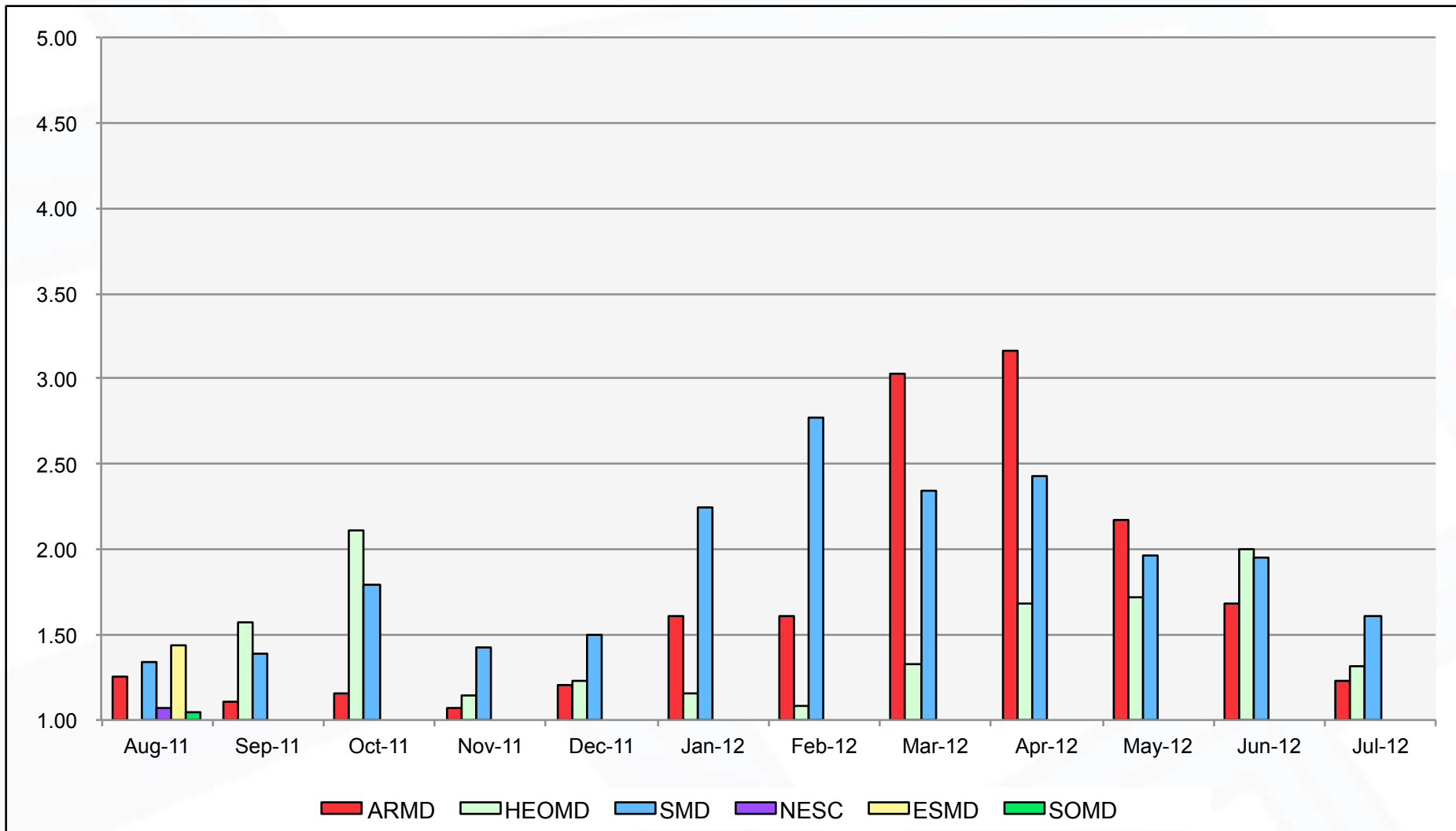


July 2012

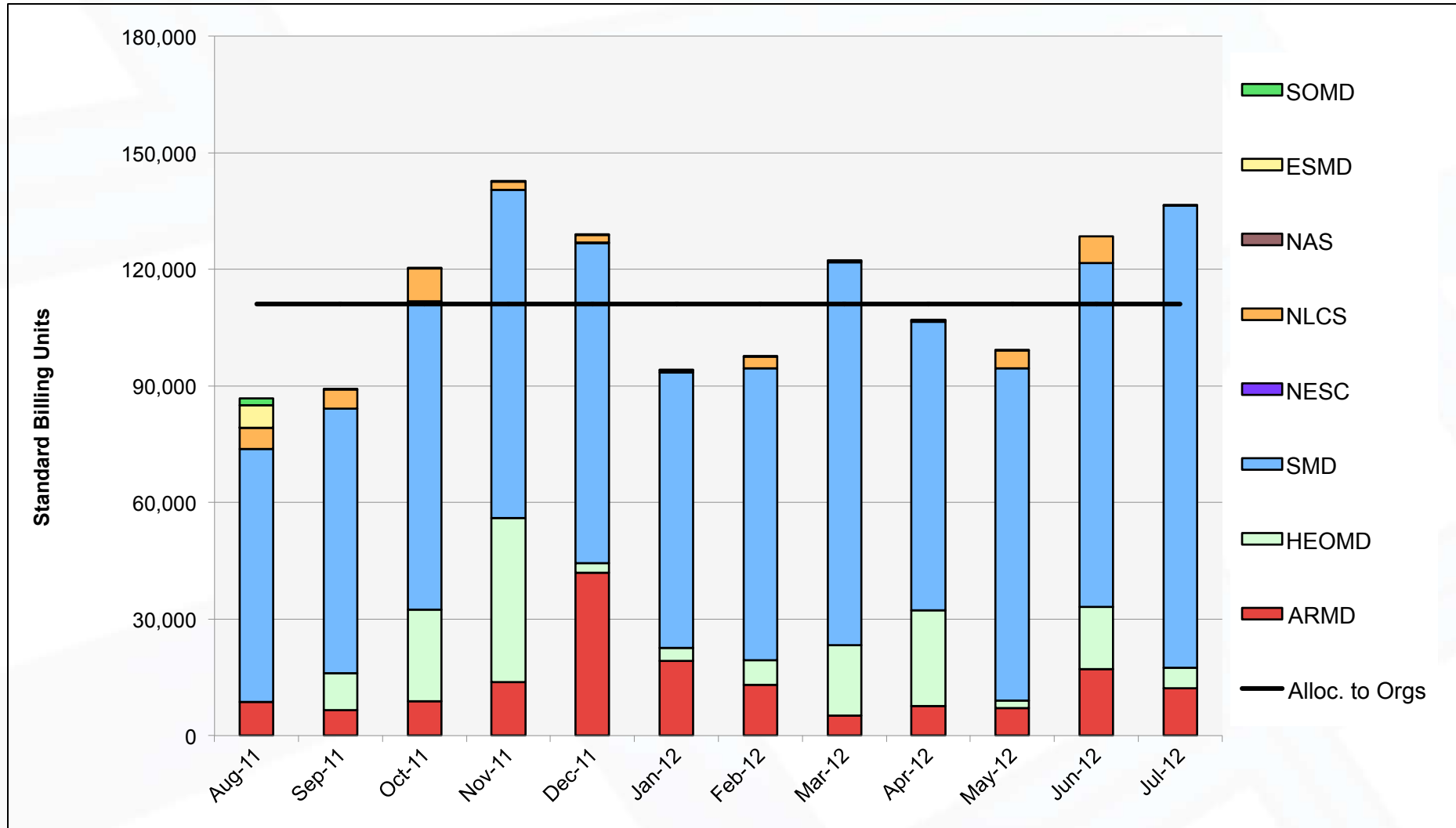
Pleiades: Average Time to Clear All Jobs



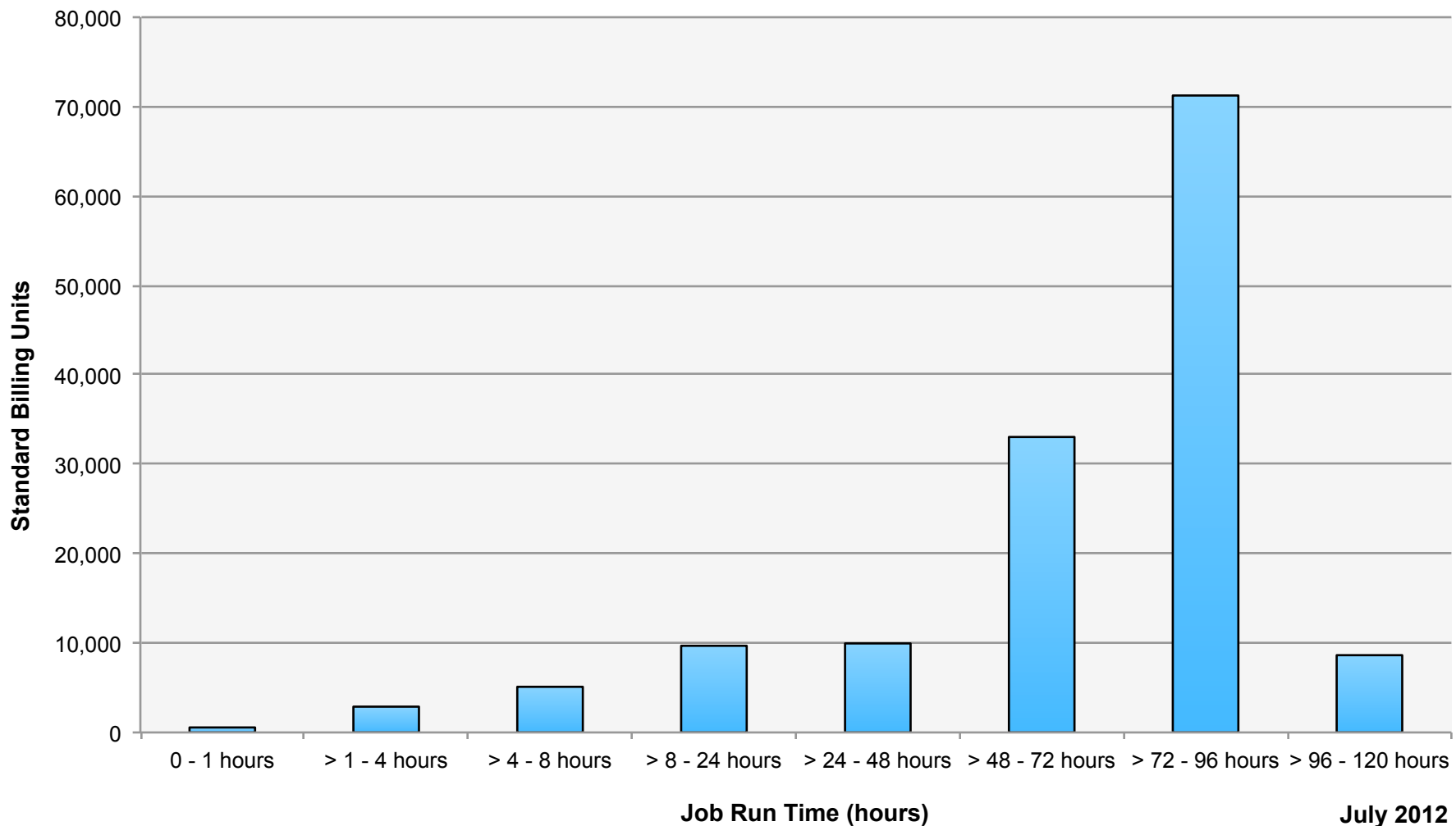
Pleiades: Average Expansion Factor



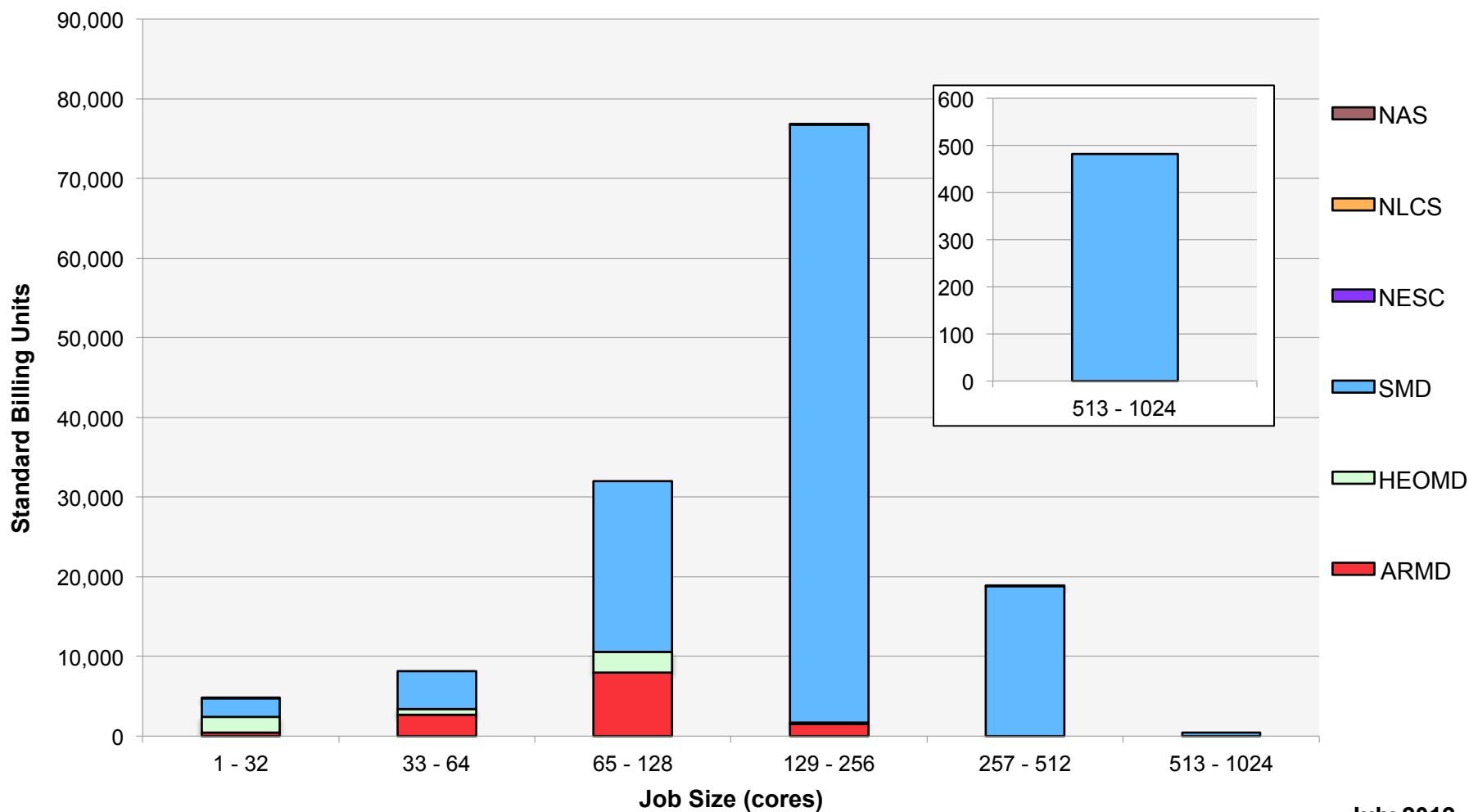
Columbia: SBUs Reported, Normalized to 30-Day Month



Columbia: Monthly SBUs by Run Time

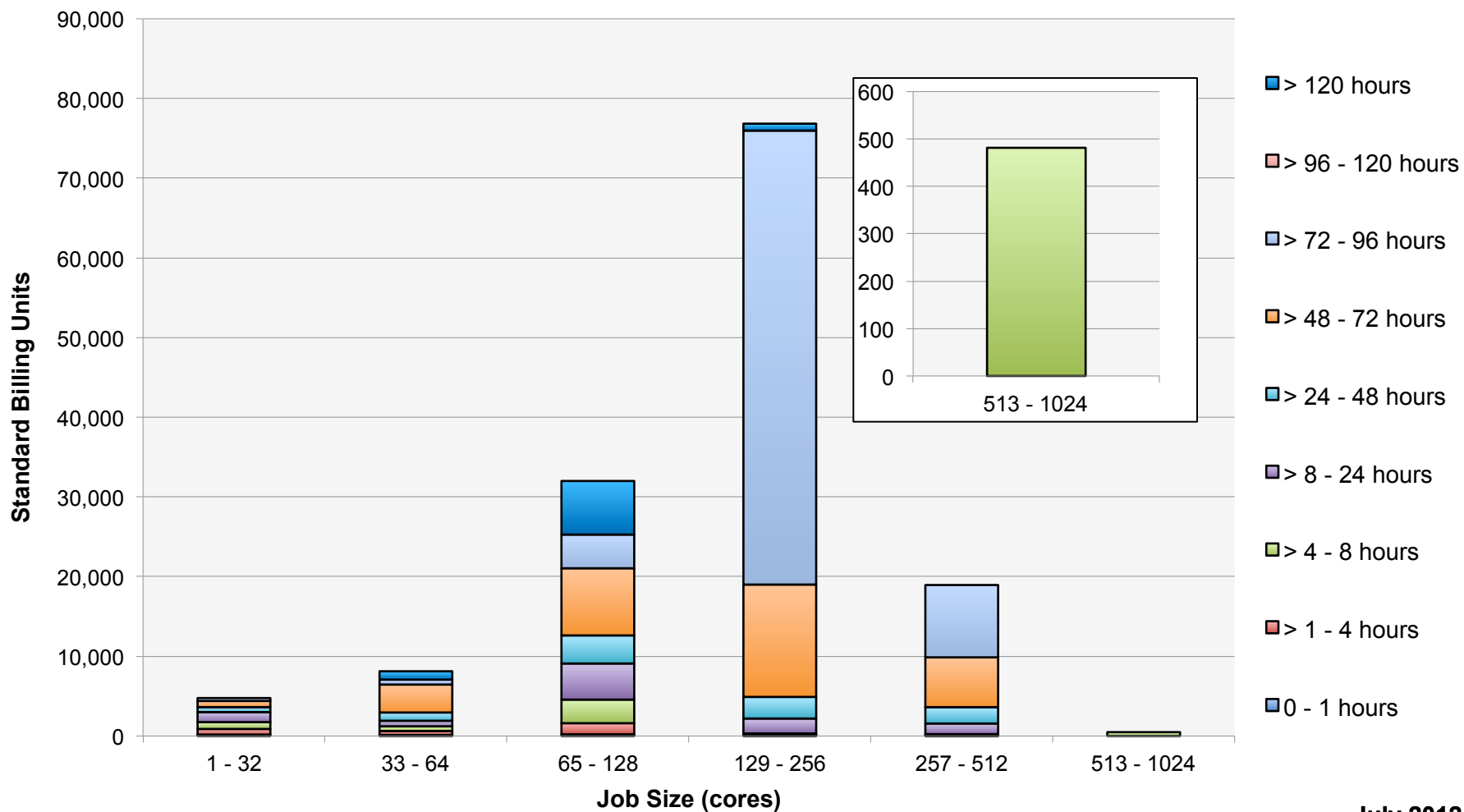


Columbia: Monthly Utilization by Size and Mission



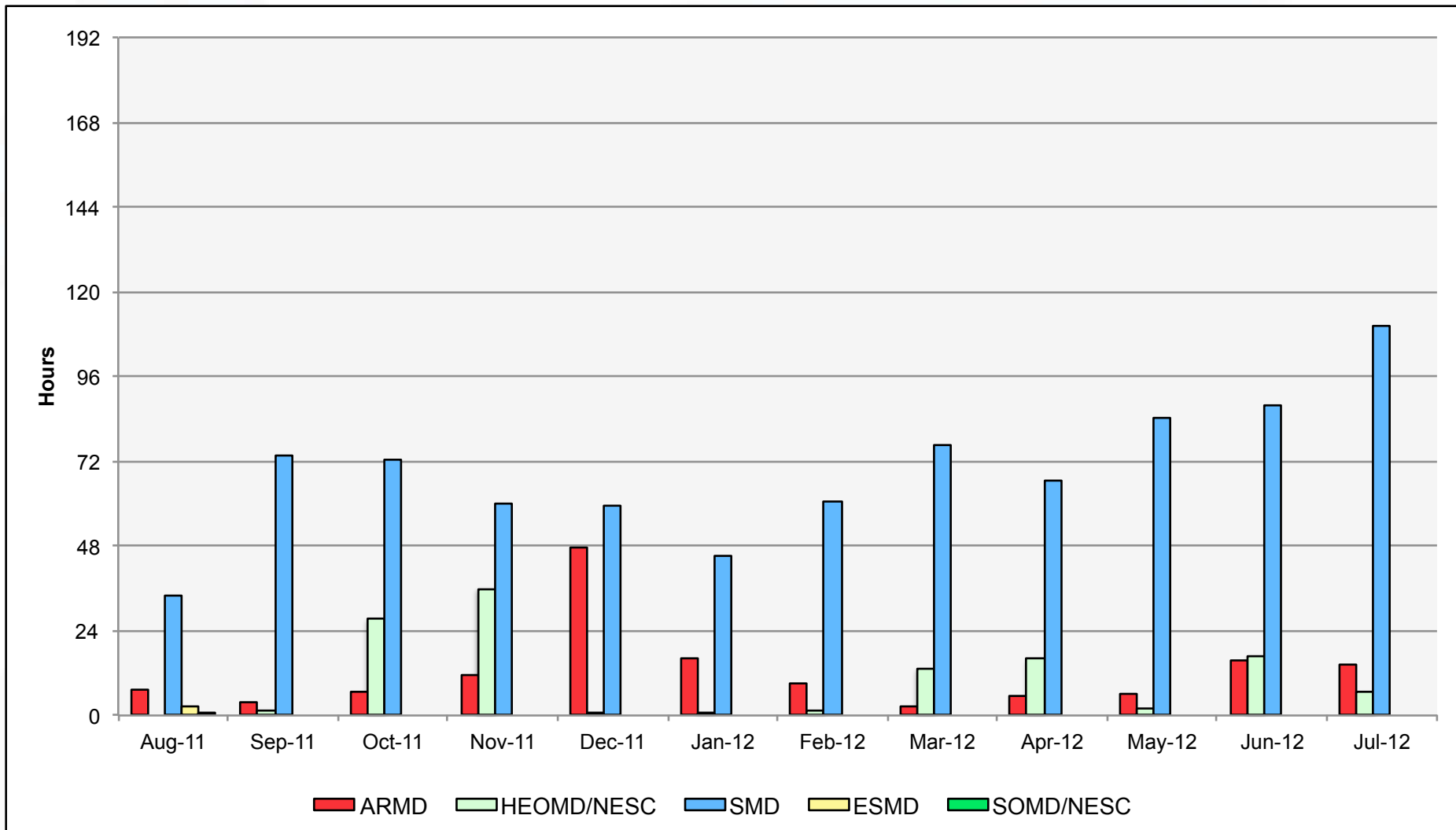
July 2012

Columbia: Monthly Utilization by Size and Length



July 2012

Columbia: Average Time to Clear All Jobs



Columbia: Average Expansion Factor

